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EDWIN DUNKIN, F.R.S., President, in the Chair.

Charles Michie Smith, B.Sc., F.R.S.E., Professor of Physical Science, Madras Christian College; and

Arthur Stanley Williams, Walsingham House, West Brighton;

were balloted for and duly elected Fellows of the Society.

The Observations of the Moon made at the Radcliffe Observatory during the Year 1883, *and a Comparison of the Results with the Tabular Places from Hansen's Lunar Tables.* By E. J. Stone, M.A., F.R.S.

The present paper contains the Right Ascensions and North Polar Distances of the Moon as deduced from the observations made at the Radcliffe Observatory during the year 1883. I have compared these results with those deduced from Hansen's Lunar Tables on two suppositions:

1. That the mean times, found in the usual way from the sidereal times at mean noon given in the *Nautical Almanac*, were not changed in 1864;
2. That the mean times were changed in 1864 in accordance with the views which I have explained in Papers already communicated to the Society.

The corrections which I have applied to the mean times are computed from the expression

$$+0^{s}\cdot55 + 24^{h} \times \frac{0\cdot060216}{1296027\cdot618184} \times \text{days from 1864 Jan. 1,}$$

and are added to the adopted sidereal times at each mean noon since 1864. Here $+0^{s}\cdot55$ is a constant, but the second term is a variable one, and soon becomes important. The necessity for such a correction, after the adopted value of the Sun's mean

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motion in longitude was changed in the expression of the sidereal time in terms of the mean solar time from n to $n+\delta n$,

$$\frac{\delta n}{n}=\frac{0{\cdot}060216}{1296027{\cdot}618184},$$

follows from exactly the same reasoning as that which compels us to replace the sidereal time

$$=s=a+(24^{\mathrm{h}}+n)t,$$

when t is expressed in days by

$$s=a+24^{\mathrm{h}}\left(1+\frac{\delta n}{n}\right)t'+(n+\delta n)t',$$

or

$$s=a+24^{\mathrm{h}}\times 365{\cdot}25t'+365{\cdot}25\,nt',$$

when we adopt instead of a day a Julian year of 365·25 such days as our unit. In this case

$$\frac{\delta n}{n}=364{\cdot}25\,;$$

but if we were to omit the term

$$24^{\mathrm{h}}\,.\,\frac{\delta n}{n}\,.\,t',$$

and to write

$$s=a+24^{\mathrm{h}}t'+365{\cdot}25\,nt',$$

and then to assume that at the r^{th} *day* from epoch we could take $t'=r$, and thus find sidereal time at r^{th} *mean noon* $=365{\cdot}25\,nr$, we should have made identically the same error in theory which we have made since 1864. The only difference is that when

$$\frac{\delta n}{n}=364{\cdot}25$$

the errors which arise from such mistakes would be sufficiently large to prevent them being made in practice, and such errors have, therefore, never been made in practical astronomy; but when

$$\frac{\delta n}{n}=\frac{0{\cdot}060216}{1296027{\cdot}618184},$$

the errors accumulate so slowly that it is only after a lapse of some years that their effects become sufficiently sensible to be separated from personal errors and the defects of Lunar theory. But, if the omission of the term

$$24^{\mathrm{h}}\,.\,\frac{\delta n}{n}\,.\,t'$$

is absurd when

$$\frac{\delta n}{n}$$

is large, it cannot be correct to omit this term when

$$\frac{\delta n}{n}$$

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is small. As my theoretical views have been disputed, I have shown that this correction does, as a matter of fact, remove the discordances between Hansen's Lunar Tables and observations over the whole period of twenty years which have elapsed since the change in the units of time took place. The following are the facts bearing on this question :—

(1) Hansen's Lunar Tables represented the motions of the Moon with great accuracy for many years before 1863. The mean yearly error, 1847–1864, was always small, and generally about $-1''\cdot5$.

(2) In 1864 we changed the scale upon which our mean times are measured, or the ratio of the sidereal day to the tabular day. This is now admitted.

(3) I have given mathematical proofs which no one, at all events at present, has shown to be in error, that this change of units requires the correction

$$24^{\mathrm{h}}\cdot\frac{\delta n}{n}\cdot t$$

to be applied to our present sidereal times at mean noon, in order to obtain the sidereal time at Bessel's old mean noon to which our tabular quantities refer. This correction is equivalent to a change of the adopted unit of time in the proportion of

$$1 : \left(1+\frac{\delta n}{n}\right).$$

(4) When this correction is applied to our mean times, the discordances between Hansen's Lunar Tables and observations for the twenty years 1864–1883 are very little greater than they were before 1863.

The statements which have been made that the times are thus over-corrected do not appear to be warranted by the facts. The mean error in longitude was negative for years before 1864, and should, therefore, be negative now, if no change had been made and Hansen's Tables were perfect. The changes in the errors of Hansen's Tables are very small, as shown by the results. The mean of the four greatest negative errors in the comparison of Hansen's Tables in longitude with the Greenwich observations was $-9''\cdot08$ in 1862, and $-6''\cdot95$ in 1863; whilst the mean of the four greatest positive errors was respectively $+1''\cdot51$ in 1862, and $+3''\cdot52$ in 1863. The Radcliffe observations in 1882 and 1883 show corresponding mean errors of $-7''\cdot17$ and $-6''\cdot60$, and $+3''\cdot93$ and $+3''\cdot50$ respectively. There is therefore no over-correction. The error in time increases from $0^{\mathrm{s}}\cdot55$ at the rate of about $1^{\mathrm{s}}\cdot46$ per annum, but Hansen's Tables correctly represent the motion over the twenty years. This cannot be the result of an accident: the quantities dealt with are too large.

As my paper which gave the separate results of a comparison between Hansen's Lunar Tables and the Greenwich Observations 1864–1881, when the mean times were corrected in accordance with my theoretical views, has not been printed, I have appended to this paper the mean annual results.

TABLE I.

Radcliffe Observations of the Moon, 1883.

Corr. to be subtracted from M.T. computed directly from Sid. Time at Mean Noon from N.A.	Obs.	Day.	Observed R.A.	Secs. of Hansen's R.A.	Diff. (H.−Obs.)	Corr. due to Error in Time.	Residual Error in R.A.	Observed N.P.D.	Secs. of Hansen's N.P.D.	Diff. (H.−Obs.)	Corr. due to Error in Time.	Residual Error in N.P.D.
s			h m s	s	s	s	s	° ′ ″	″	″	″	″
28·36	R.	Jan. 15	1 15 48·32	49·12	+0·80	−1·08	−0·28	79 31 19·00	16·22	−2·78	+5·05	+2·27
28·36	W.	16	2 13 2·94	3·83	+0·89	−1·10	−0·21	75 28 61·52	58·71	−2·81	+4·12	+1·31
28·37	F.B.	18	4 10 51·69	52·48	+0·79	−1·13	−0·34	70 22 5·83	5·94	+0·11	+1·59	+1·70
28·39	W.	23	8 53 4·01	4·95	+0·94	−0·97	−0·03	77 39 22·50	25·93	+3·43	−4·16	−0·73
28·40	R.	26	11 17 5·30	6·28	+0·98	−0·88	+0·10	89 56 22·27	26·05	+3·78	−4·91	−1·13
28·47	W.	Feb. 13	2 53 51·74	52·51	+0·77	−1·13	−0·36	73 27 58·92	57·11	−1·81	+3·39	+1·58
28·48	F.B.	15	4 52 40·49	41·40	+0·91	−1·13	−0·22	69 55 56·51	59·03	+2·52	+0·62	+3·14
28·48	R.	16	5 51 7·12	7·75	+0·63	−1·10	−0·47	70 0 9·52	9·91	+0·39	−0·75	−0·36
28·50	R.	19	8 34 44·81	45·41	+0·60	−0·98	−0·38	76 26 13·53	17·15	+3·62	−3·84	−0·22
28·51	W.	22	10 59 52·46	53·55	+1·09	−0·89	+0·20	88 13 28·20	32·28	+4·08	−4·89	−0·81
28·51	R.	23	11 46 6·56	7·43	+0·87	−0·89	−0·02	92 26 37·33	41·09	+3·76	−4·83	−1·07
28·62	R.	Mar. 23	12 16 36·41	37·31	+0·90	−0·89	+0·01	95 6 35·24	39·98	+4·74	−4·66	+0·08
28·64	R.	26	14 39 49·06	49·93	+0·87	−0·96	−0·09	105 29 38·11	39·28	+1·17	−3·09	−1·92
28·72	R.	April 16	9 41 53·88	54·29	+0·41	−0·93	−0·52	81 36 49·84	53·87	+4·03	−4·48	−0·45
28·74	R.	20	12 47 44·17	44·91	+0·74	−0·91	−0·17	97 45 42·66	45·89	+3·23	−4·44	−1·21
28·74	F.B.	21	13 35 1·44	2·31	+0·87	−0·93	−0·06	101 23 47·01	50·22	+3·21	−3·99	−0·78
28·76	W.	25	16 59 48·20	49·43	+1·23	−1·05	+0·18	109 42 25·96	23·16	−2·80	−0·41	−3·21

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Corr. to be subtracted from M.T. computed directly from Sid. Time at Mean Noon from N.A.	Obs.	Day.	Observed R.A.	Secs. of Hansen's R.A.	Diff. (H.–Obs.)	Corr. due to Error in Time.	Residual Error in R.A.	Observed N.P.D.	Secs. of Hansen's N.P.D.	Diff. (H.–Obs.)	Corr. due to Error in Time.	Residual Error in N.P.D.
s			h m s	s	s	s	s	° ′ ″	″	″	″	″
28·77	R.	April 29	20 40 28·25	29·31	+1·06	–1·07	–0·01	102 52 34·19	29·53	–4·66	+4·21	–0·45
28·84	R.	May 16	11 45 34·31	34·80	+0·49	–0·89	–0·40	92 25 4·68	7·87	+3·19	–4·79	–1·60
28·86	F.B.	22	16 42 15·19	16·35	+1·16	–1·05	+0·11	109 33 40·03	38·35	–1·68	–0·80	–2·48
28·87	R.	23	17 37 11·21	12·19	+0·98	–1·07	–0·09	109 44 11·88	8·67	–3·21	+0·40	–2·81
28·87	F.B.	24	18 32 45·93	46·92	+0·99	–1·08	–0·09	108 50 63·65	59·80	–3·85	+1·65	–2·20
28·95	W.	June 12	11 28 8·39	9·19	+0·80	–0·91	–0·11	90 44 11·16	16·02	+4·86	–4·88	–0·02
28·96	W.	14	13 1 0·04	1·01	+0·97	–0·92	+0·05	98 43 39·19	42·85	+3·66	–4·38	–0·72
29·09	W.	July 17	17 50 6·01	6·82	+0·81	–1·10	–0·29	109 36 27·27	26·01	–1·26	+0·61	–0·65
29·10	W.	19						106 19 9·74	5·84	–3·90	+3·19	–0·71
29·12	R.	26	2 18 46·18	47·32	+1·14	–1·14	0·00	76 6 60·21	54·30	–5·91	+4·17	–1·74
29·20	R.	Aug. 13	17 25 10·48	11·33	+0·85	–1·08	–0·23	109 33 1·72	1·06	–0·66	0·00	–0·66
29·20	W.	14	18 21 8·01	9·05	+1·04	–1·11	–0·07					
29·21	W.	16	20 15 29·52	30·64	+1·12	–1·12	0·00	104 38 34·36	30·52	–3·84	+3·78	–0·06
29·22	W.	18	22 9 57·41	58·83	+1·42	–1·12	+0·30	96 31 61·69	58·37	–3·32	+5·54	+2·22
29·23	W.	22	2 0 37·30	38·59	+1·29	–1·16	+0·13	77 30 41·25	37·62	–3·63	+4·56	+0·93
29·24	R.	23	3 0 24·64	25·63	+0·99	–1·18	–0·19	74 5 36·79	35·59	–1·20	+3·41	+2·21
29·32	F.B.	Sept. 13	20 44 25·51	26·54	+1·03	–1·12	–0·09	102 47 15·04	10·88	–4·16	+4·24	+0·08
29·33	W.	15	22 38 51·20	52·27	+1·07	–1·13	–0·06	94 4 60·31	55·44	–4·87	+5·81	+0·94
29·33	F.B.	16	23 36 54·29	55·65	+1·36	–1·15	+0·21	89 2 16·42	11·53	–4·89	+6·02	+1·13

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Corr. to be subtracted from M.T. computed directly from Sid. Time at Mean Noon from N.A.	Obs.	Day.	Observed R.A.	Secs. of Hansen's R.A.	Diff. (H.—Obs.)	Corr. due to Error in Time.	Residual Error in R.A.	Observed N.P.D.	Secs. of Hansen's N.P.D.	Diff. (H.—Obs.)	Corr. due to Error in Time.	Residual Error in N.P.D.
s			h m s	s	s	s	s	° ′ ″	″	″	″	″
29·34	F.B.	Sept. 17	0 35 55·09	56·64	+1·55	−1·17	+0·38	83 59 32·85	25·90	−6·95	+5·79	−1·16
29·44	R.	Oct. 12	22 9 14·29	15·15	+0·86	−1·11	−0·25	96 28 58·55	53·26	−5·29	+5·41	+0·12
29·44	W.	13	23 6 2·44	3·42	+0·98	−1·13	−0·15	91 41 18·16	14·39	−3·77	+5·89	+2·12
29·45	W.	16	2 6 30·62	31·92	+1·30	−1·24	+0·06	77 19 59·79	57·49	−2·30	+4·70	+2·40
29·46	F.B.	17	3 10 21·05	22·31	+1·26	−1·27	−0·01	73 52 45·45	43·07	−2·38	+3·38	+1·00
29·47	R.	21	7 20 23·45	24·59	+1·14	−1·13	+0·01	73 2 59·29	61·19	+1·90	−2·60	−0·70
29·55	R.	Nov. 9	22 39 12·09	12·89	+0·80	−1·09	−0·29	93 59 51·12	47·70	−3·42	+5·52	+2·10
29·55	F.B.	10	23 34 44·28	45·24	+0·96	−1·12	−0·16	89 12 8·58	5·17	−3·41	+5·81	+2·40
29·56	R.	12	1 32 14·97	15·81	+0·84	−1·21	−0·37	79 38 52·17	49·86	−2·31	+5·22	+2·91
29·58	R.	16	5 51 22·97	24·23	+1·26	−1·27	−0·01	70 54 47·79	47·27	−0·52	−0·64	−1·16
29·60	R.	22	11 18 56·86	57·89	+1·03	−0·94	+0·09	89 23 6·35	12·44	+6·09	−4·91	+1·18
29·65	W.	Dec. 5	21 27 18·78	19·71	+0·93	−1·05	−0·12	99 52 44·84	40·34	−4·50	+4·61	+0·11
29·68	F.B.	12	4 10 13·52	14·60	+1·08	−1·30	−0·22	71 46 9·08	8·69	−0·39	+2·03	+1·64
29·69	R.	14	6 21 8·05	9·14	+1·09	−1·27	−0·18	71 14 14·22	16·17	+1·95	−1·37	+0·58
29·69	F.B.	15	7 23 50·56	51·71	+1·15	−1·21	−0·06	73 1 6·26	8·70	+2·44	−2·80	−0·36
	Mean of errors without regard to sign	...			0·982		0·169			3·173		1·270
	Mean errors for year	... ...			+0·982		−0·095			−0·686		+0·096

Observers: W. = Mr. Wickham. R. = Mr. Robinson. F.B. = Mr. F. Bellamy.

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Table II.

Radcliffe Observations of the Moon, 1883. *Errors of Longitude and Ecliptic N.P.D.*

Day 1883.	Errors of Longitude.		Errors of Ecl. N.P.D.	
	Corrected for Error in Time.	Uncorrected.	Corrected for Error in Time.	Uncorrected.
Jan. 15	−4″·69	+11″·99	+0″·55	+1″·87
16	−3·31	+13·13	+0·23	+1·64
18	−5·04	+10·95	+0·79	+2·15
23	−0·63	+14·23	−0·58	−0·48
26	+0·94	+15·09	−1·63	−2·28
Feb. 13	−5·41	+11·13	+0·02	+1·46
15	−3·45	+12·45	+2·76	+4·00
16	−6·63	+ 8·84	−0·45	+0·51
19	−5·44	+ 9·41	+1·17	+1·33
22	+2·46	+16·69	−1·90	−2·54
23	−0·70	+13·52	−0·86	−1·74
Mar. 23	+0·17	+14·25	+0·01	−1·00
26	−1·83	+12·34	−1·43	−2·72
April 16	−7·46	+ 7·10	+2·12	+1·80
20	−2·80	+11·40	−0·13	−1·31
21	−1·11	+13·09	−0·41	−1·66
25	+2·20	+17·02	−3·45	−4·57
29	−0·03	+16·24	−0·47	−0·53
May 16	−6·16	+ 8·04	+0·92	+0·01
22	+1·21	+16·04	−2·67	−3·86
23	−1·38	+13·72	−2·86	−2·68
24	+1·40	+14·26	−2·27	−3·05
June 12	−1·53	+13·02	+0·63	−0·26
14	+0·41	+14·70	−0·95	−2·15
July 17	−4·12	+11·46	−0·58	−1·46
26	−0·57	+17·61	−1·64	−0·15
Aug. 13	−3·29	+11·98	−0·47	−1·37
16	+0·01	+16·79	−0·06	−0·10
18	+3·40	+21·03	+3·66	+4·39
22	+1·46	+18·99	+1·53	+3·11
23	−3·25	+14·04	+1·35	+2·87
Sept. 13	−1·30	+15·70	−0·27	−0·06
15	+0·48	+16·73	+0·54	+1·48

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Day 1883.	Errors of Longitude. Corrected for Error in Time.	Errors of Longitude. Uncorrected.	Errors of Ecl. N P.D. Corrected for Error in Time.	Errors of Ecl. N P.D. Uncorrected.
	″	″	″	″
Sept. 16	+2·45	+20·74	+2·29	+3·57
17	+5·67	+24·00	+1·16	+2·71
Oct. 12	−3·54	+13·91	−1·21	−0·41
13	−2·90	+15·05	+1·08	+2·22
16	+0·01	+18·68	+2·56	+4·30
17	−0·41	+18·15	+0·92	+2·60
21	+0·05	+16·52	−0·71	−0·35
Nov. 9	−4·83	+12·42	+0·32	+1·32
10	−3·17	+14·62	+1·26	+2·55
12	−6·15	+12·38	+0·71	+2·39
16	−0·13	+17·92	−1·16	−0·27
22	+1·71	+16·68	+0·56	−0·45
Dec. 5	−1·72	+14·51	−0·45	+0·05
12	−3·39	+15·25	+1·04	+2·45
14	−2·54	+15·58	+0·68	+1·36
15	−0·91	+16·74	−0·23	+0·05
Mean of errors without regard to sign	2·528	14·615	1·137	1·789
Mean errors for year ...	−1·547	+14·615	+0·041	+0·342

Table III.

Observations of the Moon, 1862 to 1883. *Uncorrected and Corrected for Error in Time.*

Hansen – Observed.

Year.	R.A. Uncorrected.	R.A. Corrected.	N.P.D. Increasing Uncorrected.	N.P.D. Increasing Corrected.	N.P.D. Decreasing Uncorrected.	N.P.D. Decreasing Corrected.
	s	s	″	″	″	″
1862 Gr.	−0·191	−0·191	+0·00	+0·00	+0·02	+0·02
1863 „	−0·129	−0·129	+0·04	+0·04	−0·27	−0·27
1864 „	+0·001	−0·048	−0·18	−0·32	−0·53	−0·34
1865 „	+0·085	−0·019	−0·33	−0·60	−0·89	−0·53
1866 „	+0·135	−0·020	+0·62	+0·16	−0·53	0·00
1867 „	+0·235	+0·028	+0·80	+0·26	−0·35	+0·36
1868 „	+0·275	+0·015	+1·26	+0·36	−0·74	+0·07
1869 „	+0·295	−0·016	+0·94	−0·15	−1·05	+0·06
1870 „	+0·329	−0·044	+0·92	−0·40	−1·44	−0·12

Year.	R.A.		N.P.D.			
			N.P.D. Increasing		N.P.D. Decreasing	
	Uncorrected.	Corrected.	Uncorrected.	Corrected.	Uncorrected.	Corrected.
1871 Gr.	+0·448	+0·019	+1·93	+0·15	−2·49	−0·70
1872 ,,	+0·478	−0·002	+2·16	+0·07	−2·93	−0·64
1873 ,,	+0·522	−0·008	+3·09	+0·75	−3·11	−0·46
1874 ,,	+0·597	+0·026	+3·28	+0·64	−3·53	−0·44
1875 ,,	+0·649	+0·026	+3·03	+0·03	−3·40	−0·15
1876 ,,	+0·637	−0·040	+4·11	+0·57	−3·05	+0·73
1877 ,,	+0·585	−0·146	+4·76	+0·68	−2·95	+0·54
1878 ,,	+0·530	−0·251	+4·47	+0·22	−2·29	+1·32
1879 ,,	+0·613	−0·241	+4·25	+0·41	−3·32	+0·48
1880 ,,	+0·663	−0·232	+3·66	−0·27	−3·44	+0·34
1881 ,,	+0·687	−0·266	+3·30	−0·40	−3·98	0·00
1882 ,,	+0·82					
1882 Rad.	+0·858	−0·162	+2·73	−0·83	−3·44	+0·70
1883 ,,	+0·982	−0·095	+2·60	−0·81	−3·06	+0·75

On the Proper Motions of Forty Stars in the Pleiades, both Absolute and Relative. By Prof. C. Pritchard, D.D., F.R.S.

(*Abstract.*)

The Memoir which I am about to present to the consideration of the Society, consists mainly of two separate and entirely independent investigations of the proper motions of forty stars in the *Pleiades*. It originated primarily in a desire to test the capacity of a new Differential Micrometer which I had devised, under the expectation that it would enable me to measure with great accuracy celestial arcs to the extent of some twenty minutes; a distance which seemed to me considerably greater than could be reached with security by means of any filar micrometer with which I was acquainted. I purposed to apply this new form of micrometer, if successful, to a systematic investigation of stellar parallax, which I then intended to make an especial object of research, in the observatory under my direction at Oxford. I applied the instrument in the first instance to the *Pleiades*, in consequence of a remark* made by Bessel, to the effect that his own measures of the relative coordinates of certain members of this historic group had been effected with so much accuracy by means of his heliometer, that advantage might henceforth be taken of his scrupulous labours therein, to test the accuracy of other instruments, and, at the same time, assist in determining their scales.

I had proceeded to a considerable extent in this investigation

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* Beobachtungen verschiedener Sterne der Plejaden, 'Astronomische Untersuchungen,' erster Band. S. 209.

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